CT-64
TERMINAL SYSTEM

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CT-64 Addendum Sheet

READ CAREFULLY BEFORE ASSEMBLY

Before assembling please make the following changes in the CT-64 assembly instructions:

Page 2 Step 6 should read "The six male printed circuit type pins should now be inserted into the blank **female** connector. . ."

Page 3 first paragraph should read" .When installing J1, cut off pin #2 with wire cutters. . ." Do not cut off pin 3 as in the instructions.

On page 10 of the instructions a wiring table is missing. The wiring should be done as follows.

FEMALE PINS		FEMALE PINS
CT-64 J10 pin 2	→	N2 pin 1 (GND)
CT-64 J10 pin 3	→	N2 pin 4 (VIDEO)

On Page 10 the available outputs on J1 should be as follows:

1	Spare	3	Clock out
2	INDEX	4	Clock in

Notice that the wiring pictorial printed on the back of the large schematic also shows these points in correctly—the connections above are correct.

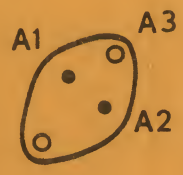
When installing C11 you will note that a hole may be missing in the board. The capacitor can be soldered directly to the top foil at this location rather than trying to drill out the hole.

When installing capacitors C3, C4, C23 and C34 you will note that the instruction set calls for 0.01 mfd mylar capacitors. Your kit may be supplied with disc capacitors. Either disc or mylar capacitors can be used.

On the top layout for the main board the polarity of electrolytic capacitor C24 is unclear. This capacitor should be installed with its + terminal nearest to IC24

When installing transistor Q3 on the main board you may have a different case style than what is shown on the pictorial. This transistor should be installed with the flat side as shown below:

When installing the heatsink to the chassis be sure to orient the heatsink and regulators exactly as shown in the chassis pictorial On some chassis it is possible to mount the heatsink incorrectly



When assembling the memory board no mention is made of installing the resistors. They should be installed immediately after installing the capacitors.

In some installations the beeper may be too sensitive to power line transients. If this is the case install a 1K ohm ¼ watt resistor in series with the line going from IC39 pin 3 to the base of Q6.

If your computer sends out vertical tabs that cause an annoyance by changing the axis of scrolling, the vertical tab function can be disabled by cutting the line going to IC44 pin 13.

When installing R45 in the CT-S board if a 22K ohm resistor is supplied in place of a 1K resistor, the 22K should be used.

If, when operating with 32 char./line the desired screen width can not be obtained, C20 can be changed to 39pF rather than 100pF.

Assembly Instructions - CT-64 CRT Terminal

Introduction

The CT-64 unit is designed to store and display up to two individual pages of 16 lines of 32 or 64 characters on a video monitor. Operator data input to the terminal can be from most any ASCII source providing the 7 bits of parallel alphanumeric data, however, an ASCII keyboard like our KBD unit will normally be used. A serial interface option is provided for use in computer applications. The power required for the unit is +5.0 volts @ 2.25 amps, -3 volts @ 20 mA, -12 volts @ 60 mA, and +12 volts at 10 mA; all at 5% regulation.

Features of the CT-64 include: 64 or 32 characters per line-jumper programmable, 50 or 60 Hz operation, upper and lower case ASCII character set, white on black or black on white operation, control character printing (if desired), screen reversal on individual characters for highlighting and selectable page mode or scrolling operation. When the unit is assembled, it should be done so, one board at a time, in accordance with the instructions.

Main PC Board Assembly

NOTE: Since all of the holes on the PC board have been plated thru, it is only necessary to solder the components from the bottom side of the board. The plating provides the electrical connection from the "BOTTOM" to the "TOP" foil of each hole. It is important that none of the connections be soldered until all of the components of each group have been installed on the board. This makes it much easier to interchange components if a mistake is made during assembly. Be sure to use a low wattage iron (not a gun) with a small tip. Do not use acid core solder. We will not guarantee or repair any kit on which either product has been used. Use only the solder supplied with the kit or a 60/40 alloy resin core equivalent. Remember all of the connections are soldered on the bottom side of the board only. The plated-thru holes provide the electrical connection to the top foil.

(√) Read this instruction set completely to familiarize yourself with the unit and its options.

(√) Attach all of the resistors to the board. As with all other components unless noted, use the parts list and component layout drawing to locate each part and install from the "TOP" ("COMP") side of the board bending the leads along the "BOTTOM" ("BACK") side of the board and trimming so that 1/16" to 1/8" of wire remains. Solder.

(√) Install all of the capacitors on the board excluding capacitor C15. Be sure to orient the electrolytic capacitors correctly. The polarity is indicated on the component layout drawing. Solder.

(✓) Install the transistors and diodes on the board. The diodes must be turned so the banded end corresponds with that shown on the component layout drawing, and the transistors must be turned to match the outlines on the component layout drawing as well. If a transistor is supplied in a round package rather than a flat sided package as shown, the transistor should be inserted so that the natural lead configuration matches with the three triangular holes in the board. Solder.

(✓) Install all of the integrated circuits except IC22 on the board being very careful to install each in its correct position. Do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The semicircle notch on the end of the package is used for reference and should match with that shown on the component layout drawing for each of the IC's. Make sure the integrated circuits are down firmly against the board and solder.

(✓) Now install electrolytic capacitor, C15, in is proper location between integrated circuits, IC 1 and IC 8. Be sure to orient it correctly. Solder.

(✓) Now that most of the components have been installed on the board, double check to make sure that all have been installed correctly in their proper location.

(✓) Now check very carefully to make sure that all components have been soldered. It is very easy to miss some connections when soldering which can really cause some hard to find problems later during the check out phase. Also check for solder "bridges" and "cold" solder joints which are also a common problem.

(✓) The six male printed circuit type pins should now be inserted into the blank female connector housing that does not have the nylon insulation between the pins. Do not confuse these pins with the crimp type which look very similar. The pins must be inserted from the back side of the connector into the housing until they snap into place. Orient the connector exactly as it is shown on the component layout drawing and install it in the J10 position from the "TOP" side of the board. Solder.

(✓) Attach wafercon connectors J9 and J11 to the circuit board from the "TOP" side making sure to orient them exactly as shown in the component layout drawing. Note that these connectors already have the pins installed. Make sure all of the pins are firmly against the nylon support. They can work loose when pressing them against the circuit board. Solder.

(✓) Now install all of the straight pin male connectors, J1 thru J8. Insert the connectors from the "TOP" side of the board so the shorter pinned side goes into the board. Solder

each connector after making sure that the connector is down firmly against the board. When installing J1, cut off pin #2 with wire cutters. Later a plug will be installed in the mating connector to complete the indexing.

(✓) In order to prevent the plug-on serial interface board from being accidentally installed backwards, a pin has been allocated for indexing on the serial interface board slot. There were no unused pins on the MEMORY board so an indexing pin was not provided. Using a pair of wire cutters, snip off pin 4 of J3. Later a plug will be installed in the female connector of the serial interface board to complete the indexing. Be sure to cut the right pin the first time.

(✓) Now go back and recheck all of the connections on the board to be sure everything has been soldered and to see that there are no solder "bridges" or "cold" solder joints. Note that the connectors J9, J10, J11 and their pins have been supplied with their mate. These should be set aside and used as called for later in the instructions.

(✓) Using a cotton swab and some laquer thinner, clean the circuit board and solder connections within a 1" radius of transistors Q4 and Q5 as well as the leads and cases of transistors Q4 and Q5. Be very careful with the lacquer thinner since it is very flammable. The lacquer thinner will remove excess flux and contaminants which may cause problems in this portion of the circuit. It air drys very quickly and need not be washed off.

( ) At this point you are ready to program the board to fit your particular application. In order for the CT-64 to be as flexible as possible it is necessary that many of the terminal's functions be left jumper programmable at the discretion of the user. If you are unfamiliar with terminal systems, the following is a list of some of the more common uses for the CT-64 and recommended configurations. These descriptions are general guidelines only and may need to be modified slightly for your application.

TV Typewriter Use - No Computer

In order to just display characters on a screen the only elements necessary are the CT-64 main board, memory board, keyboard and power supply. For this use, the page mode may be desired rather than the normal scrolling mode. In any case it is best to build the terminal with the minimum number of jumpers first to be sure it works, then re-configure to fit your needs.

Use with SWTPC 6800 Computer (or equiv.)

When using the CT-64 with any type computer system the serial interface board is necessary. Since the main use of the CT-64 in conjunction with the computer will be for writing and listing programs, we suggest the following configuration:

64 characters/line
scrolling mode
blinking cursor } ------ { Initiated during normal power up - no additional jumpers necessary if the UP to S jumper is selected
normal field
inhibited control character printing
inhibited line feeds

The CT-64 should initially be built in this state and later modified to accommodate your particular needs.

Using the CT-64 Through a Modem

Most time sharing computers are set up to accept the same configuration as described for the SWTPC 6800 computer.

Board Programming

Read each programming step carefully to see if it pertains to your use. The only steps necessary to bring up a working terminal are those flagged with a * and we suggest that you try the terminal with only these jumpers installed initially. The other steps describe options which may or may not be of interest.

(√) * Install the appropriate KP (keypressed) jumper. Jumper location C adjacent to IC31 is provided for this. If your keyboard strobe is positive going and narrow, or if negative and the data is held for at least 100 nanoseconds after the trailing edge of the strobe pulse, solder a jumper wire from pad C to -. Most keyboards, including our KBD units, will work in this configuration. Jumpering C to + instead is used for positive edge level triggering where the pulse is clean and there is no ringing.

(√) * Install the appropriate jumper to set up the power-on initialization to bring up the terminal in either the page or scrolling mode. Connect a jumper from UP to S for scrolling or from UP to P for page mode.

(SWITCH)

(√) * The board should now be jumpered for either 32 or 64 characters/line. Jumper locations D by IC-40, E by IC28 and F by IC14 are provided for this. At location E install a jumper from E to the appropriate 32 or 64 pad. At location F install 2 parallel jumpers as denoted for 64 characters or the J shaped jumper for 32 char./line.

Finally at location D install the appropriate 64 or 32 character jumper. The CT-64 JUMPERS pictorial can be used as a reference if it is unclear where the jumpers should be installed.

(√) * The CT-64 comes pre-programmed for U.S. 525 line, 60 Hz operation. For operation in European countries using 50 Hz, 625 line monitors install a jumper between the G and G terminals by the letter G on the board (adjacent to IC7). Also cut the trace denoted by the >< symbol on the board.

( ) If it is desired to enable the control character printing feature of the terminal (a CTRL. G will display as a ^{B}E on the screen, for example) cut the trace next to the B terminal next to IC 39. Also jumper from the B terminal to the $\overline{=}$ terminal next to IC38.

(SWITCH)

( ) The CT-64 comes pre-programmed to scroll up one line upon receiving a carriage return. In this mode line feeds are inhibited so that a CR/LF will generate only one line feed on the screen. If you are using the CT-64 with a computer that uses a carriage return as a line entry character the terminal can be set up to initiate scrolling on line feeds rather than carriage returns. This will prevent the extra line feed from being displayed on the terminal when typing in a program as in BASIC. If you desire to leave the extra line feed (it will not show up in your program- only on the screen at type in time) no jumpering is needed. If you wish to change the CT64 to ignore CR's and scroll on LF's cut the land next to the H terminal (adj. to IC45) and jumper the two small pads next to the H.

( ) The CT-64 is designed to power up with a blinking cursor homed up to the top of a clean page. The terminal will be in either the page or scrolling mode, depending on the power up jumper installed earlier. This power up sequence is accomplished by R65, C33 and D7. A number of other modes of operation are possible (solid cursor, cursor off, etc.) A number of locations have been provided on the board to enable these features. To enable a particular function, the terminal should receive <u>one</u> grounding pulse at the appropriate terminal. Once the CT-64 is put in another mode (such as solid cursor) another pulse at the same location will return the terminal to the other state. NOTE: With the power up jumper set for SCROLLING operation, toggling the SCRL pad will have no effect. The locations and options are as follows:

RVSE - Reverses the display on the screen (black characters on a white background)
SCRL - Removes the terminal from the scrolling mode and places it in the page mode
BLNK - Changes from blinking cursor to solid cursor
CUR - Turns cursor off and on
PAGE - Flips pages on each grounding pulse (whether in page or scrolling mode)
INIT - Re-initializes the terminal as during power up. C33 and D7 should be removed is INIT if connected to a decoder output for software control.

The inputs to these locations do not have switch debounce and must be provided externally if outboard pushbutton switches are used. If desired the various optional modes can be initiated by control commands from the keyboard or the computer by using the negative going outputs from the terminal's control character decoders. The use of the decoders is described later.

( ) If the terminal will be used primarily in the page mode note that the CT-64 is not configured to initiate page changes automatically at the end of a page. If auto page flipping is desired jumper from 16L to PAGE.

NOTE: MOS integrated circuits are susceptable to damage by static electricity. Although some degree of protection is provided internally within the integrated circuits, their cost demands the utmost in care. Before opening and/or installing any MOS integrated circuits you should ground your body and all metallic tools coming into contact with the leads, thru a 1 M ohm 1/4 watt resistor (supplied with the kit). The ground must be an "earth" ground such as a water pipe, and not the circuit board ground. As for the connection to your body, atttach a clip lead to your watch or metal ID bracelet. Make absolutely sure you have the 1 Meg ohm resistor connected between you and the "earth" ground, otherwise you will be creating a dangerous shock hazard. Avoid touching the leads of the integrated circuits any more than necessary when installing them, even if you are grounded. On those MOS IC's being soldered in place, the tip of the soldering iron should be grounded as well (separately from your body ground) either with or without a 1 Meg ohm resistor. Most soldering irons having a three prong line cord plug already have a grounded tip. Static electricity should be an important consideration in cold dry environments. It is less of a problem when it is warm and humid.

( ) Install MOS integrated circuit IC 22 following the precautions given in the preceding section. As it is installed, make sure it is down firmly against the board before soldering all of its leads. Do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuit should replacement ever be necessary. The "dot" or "notch" on the end of the package is used for orientation purposes and must match with that shown on the component layout drawing for the IC.

( ) Working from the "TOP" side of the circuit board, fill in all of the feed-thru's with molten solder. The feed-thru's are those unused holes on the board whose internal plating connects the "TOP" and "BOTTOM" circuit connections. Filling these feed-thru's with molten solder guarantees the integrity of the connections and increases the current handling capability.

Memory PC Board Assembly

( ) Install the capacitors on the circuit board. Insert them from the "TOP" side of the board, bend the leads along the "BOTTOM" side and trim so that 1/16" to 1/8" of wire remains.

( ) Now attach the two fifteen pin female connectors to the board. These must be installed from the "TOP" side of the board and pressed down so the connectors seat firmly against the board.

( ) The nine IC's may be installed on the board now following the precautions given earlier for MOS devices. Be sure and insert the integrated circuits from the "TOP" side of the board and orient them as is shown in the component layout pictorial. Do not bend the leads on the back side of the board. This makes it very difficult to replace the integrated circuit should it ever be necessary. Note that the memory board is designed to accomodate 16 memory IC'a rather than the 8 that are supplied with the kit. If the additional page of memory it desired 8 500nS 2102 memories can be added.

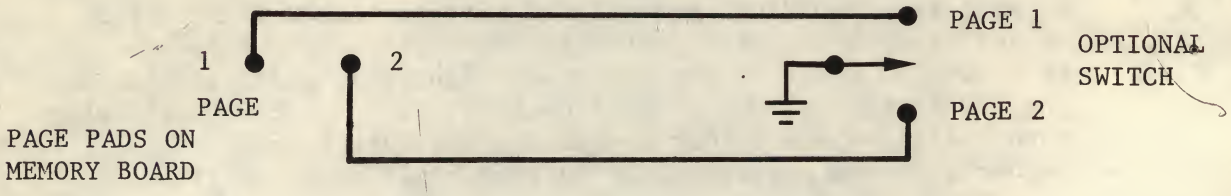
( ) Check to make sure all of the components are down firmly against the baord, installed in the right location and oriented correctly. Flip the board over so the "BOTTOM" side is up and solder all of the connections with a low wattage iron. Note that the board need only be soldered on the "BOTTOM" side. The plated-thru holes provide the electrical connections to the "TOP" foil.

( ) Now go back and check for missed solder connections and solder "bridges" and "cold" solder joints. When everything looks OK set the baord aside and do not plug the memory board onto the main PC board.

(√) Since only 8 of the 16 memory IC's have been installed run a jumper wire from the PAGE 2 terminal of the memory board to a convienient ground location. (The foil connected to the - terminal of the electrolytic capacitor on the memory board is ground)

(√) As described earlier fill in all of the feed-thrus with molten solder from the "TOP" side of the board.

(√) The CT-64 works normally in the scrolling or auto page changing mode. If desired, a SPDT center off switch can be wired into the memory board to manually select pages (if optional memory is installed) The switch should be wired as follows. (The switch is not necessary for most applications).



( ) At this point the majority of the assembly has been done on the main part of the terminal. The remaining assembly requires the interfacing of the CT-64 main board, the keyboard, the serial interface board and the power supply. When working on these additional boards work on them one at a time and do not intermix the parts. Most of the remaining instructions and the wiring table have been set up assuming that you are using the standard CT-CH chassis and cover. If you will be using a custom chassis of your own, the instructions and/or assembly order may need to be modified. When attaching the power supply, etc. to the chassis, the wiring pictorials should be used along with the instruction set to aid in the assembly. When wiring the interconnecting cables be as neat as possible. The wiring pictorial will aid in the correct routing of the cables in the chassis.

Power Supply Construction

(√) Assemble your P-200CT power supply as called for in its instruction set. Partial chassis assembly will also be outlined in the power supply instructions. After assembling the supply and verifying its operation, continue with the terminal instructions.

Keyboard Assembly

The terminal has been designed to work with almost any keyboard providing parallel ASCII output. If you are using our KBD unit then refer now to the keyboard assembly instructions. After assembling the keyboard, it will be neceasary to attach a connector and wiring harness to the unit as described below. Testing of the keyboard should be postponed and done with the main board as described later.

(b) A cable connecting the keyboard to the terminal should now be constructed as shown in the wiring table below. Note that on the first half (keyboard side) of each step a wire of the correct length should be soldered to the respective pin of the 15 pin edge type connector supplied with the keyboard. The second half of each step goes to connector pins that will plug into a 12 pin male connector housing supplied with the CT-64 kit. Solder all of the wires to the correct type pin and after all pins have been soldered and all connections made to the 15 pin straight connector insert each pin into the correct hole in the 12 pin male connector block. The pins should be inserted from the numbered side of the connector and must be done correctly the first time since the pins cannot be removed from the block after insertion. Note that the R, T, E and P terminals are not connected to anything at this time. The correct wiring of the BIT 8 input to the terminal depends on whether or not single character highlighting is desired. If it is not, connect BIT 8 to the G terminal on the 15 pin straight connector. If highlighting is desired an optional switch must be wired in. When BIT 8 is at ground potential characters will be normal. When BIT 8 is left open (BIT 8 will pull itself up to +5) the characters entered from the keyboard will be displayed in reverse field format. Do not tie the cable with wire ties at this time since other wires to R, T and E will later be added after assembling the CT-S serial interface.

Keyboard Cable Wiring Table
use light gauge wire

KEYBOARD STRAIGHT PIN CONNECTOR pin designation	WIRE LENGTH (inches)	J9 ON CT-64 MAIN BOARD Connector Pin Gender	Connector Pin #
-	18	female	6
G	18	male	3
K	18	female	10
1	18	female	1
2	18	female	4
3	18	female	5
4	18	male	7
5	18	female	8
6	18	male	12
7	18	female	11
+	18	female	2
Optional bit 8 switch		female	9

( ) The last connector to be wired that will go to the main board is the video output connector J10. Wire the connector as described in the wiring table below if you are using the CT-VM video monitor using a 18 " length of wire. Both halves of each step go to individual connector pins that plug into a 6 pin Molex male shell connectors. The connectors attached during the first half of each step should be plugged into a 6 pin male shell that will plug onto the terminal's main board, while the second half goes to the connector that connects the power supply to the monitor. If you are not using the CT-VM monitor connect an appropriate connector to proper length of wire from J10.

FEMALE PINS		FEMALE PINS
CT-64 J10 PIN 2	⟶	N12 PIN 1 (GND)
CT-64 J10 PIN 3	⟶	N12 PIN 4 (VIDEO)

( ) If you will be using the CT-64 in conjunction with a SWTPC AC-30 cassette interface, decoded reader/punch on/off commands are available at jack J1 on the main board. Also, the UART clock in and clock out lines from the serial interface have been brought to this connector. The CT-64/6800/AC-30 interconnection drawing should be used to wire the cable. Note that on the AC-30 side the cable should be connected directly to the 15 pin straight pin male connector. When wiring to the CT-64 the small individual pins that snap into the 10 pin edge type harness connector (with square holes) should be soldered to the wires and then snapped into the housing. Next, snap one of the small nylon indexing plugs into the #2 hole from the numbered side of the connector. On this particular connector, the pins should be inserted from the non-numbered side. Below is a list of the available outputs on J1.

1	~~clock out~~ SPARE	6	read off
2	~~clock in~~ INDEX	7	punch on
3	~~INDEX~~ CLOCK OUT	8	read on
4	~~spare~~ CLOCK IN	9	+5 VDC
5	punch off	10	ground

( ) Attach four stick on rubber bumpers at several locations on the BOTTOM side of the main board. They will help prevent the board from flexing and bottoming out on the chassis .

( ) Insert the four nylon standoffs in the chassis and snap the main PC Board into place and attach the keyboard connector J9 and the video output connector J10. Do no connect power supply connector J11 at this time and do not apply power. If you plan to use any of the add-on options, it is best that you wait to make sure the main board and memory works first before building and plugging them on.

(✓) The Sonalert[R] can now be fastened to the chassis and wired to the board. Insert the Sonalert into the 1 inch hole in the rear of the chassis and snap it into place. Complete the following two wiring steps using 8 inches of light gauge wire:

Sonalert + terminal ---- to ---- CT-64 main board BELL pad
Sonalert - terminal ---- to ---- CT-64 main board GND pad

( ) If you will be using the CT-VM video monitor, refer now to the monitor's instruction set for mounting and power supply connector wiring.

( ) Connect the power connector from the supply to the CT-VM monitor.

Testing and Calibration

Turn on the power and advance the monitor's brightness until the white background is faintly visible. The settings should now be left where they are until you have connected the terminal and have a character field displayed on the screen as described in the forthcoming instructions. It is also recommended that you give the unit one last check to make sure everything has been wired and installed correctly. The board has been layed out so all of the IC's are oriented the same way so check and make sure they are installed that way. Also make absolutely sure the power supply is connected correctly. Accidentally reversing the voltage may short the protection diodes D3 - D5 and hopefully protect the IC's, however, excessive current may open the diodes which in turn can damage most of the IC's on the board.

( ) Remove power and unplug the memory board if it has been plugged onto the mainboard. It should not be installed for the initial checkout.

( ) Set all trimmer resistors for the center of rotation.

( ) Attach the output of the terminal to the input jack of the video monitor thru a connecting cable.

( ) Before applying power to the unit, it is a good idea to attach a voltmeter between ground and the +5 volt bus on the unit. Easy access is provided by the two large buses extending from jack J11 running across the board on the component side. Polarity is indicated by the markings on electrolytic capactior C24

( ) With the power off connect the power supply connector J11 to the main board.

( ) Plug the unit's line cord into a wall outlet, and flip the power switch on and then quickly off again. Watch the meter and confirm that the power supply polarity is correct. Apply power again making sure the voltage comes up to +5 volts DC. If it does not, remove power and determine whether the problem is in the supply or the main board. The power supply recommended for the unit should easily provide sufficient voltage for currents up to 3 Amps, but high currents will cause reduced voltage and eventual damage to the supply and terminal. Also check the -3 and -12 supply buses to make sure these voltages are correct. The reading should be within about 10%.

( ) You should have a display of random characters on the screen probably ▒▒▒ changing back and forth on certain areas of the screen. If you do not have a readable display, adjust trimmer resistor R11 slowly until the picture becomes readable. The brightness and contrast controls on the monitor may then be adjusted to give the most attractive display. If you are not able to get a readable display, remove power and recheck all assembly procedures. If this proves fruitless, the next alternative involves probing through the circuit with an oscillioscope along with a thorough knowledge of how the circuit works. This requires a good background in digital theory and is not a recommended procedure for the novice.

( ) Adjust trimmer resistor R64 to center the display and adjust trimmer resistor R30 to give a character size that is most attractive. Making the character size too small will sometimes cause the unit to display incorrect characters, so be careful.

( ) If everything has checked out OK so far, remove power and install the memory board. Do not install the memory board if you are having problems. Its IC's are expensive and it is best left off until the problems have been corrected. Orient the board so the component side faces toward the IC's on the main board.

( ) Again power up the terminal. The display should contain a blinking cursor homed-up to the top of a clean page.

( ) If you are feeding the terminal directly from a keyboard, try all of the keys and make sure everything is working correctly. If double printing occurs, it is probably due to ringing created by excessively long wire between the keyboard or the driving device feeding the terminal. If this occurs try putting a 330 pfd capacitor from the "keypressed" strobe ouput on your keyboard to ground. Most MOS type keyboard encoders are too slow to cause problems such as this but TTL ones are not, especially if connected with 3 feet or more of wire.

( ) Check the line feed and carriage return for proper operation.

Note: Upon applying power the terminal should come up with a blinking cursor homed-up on a clean page. Remember when checking the carriage return - line feed the line feed will be inhibited when in the scrolling mode (cursor on the bottom line). Also, the CT-64 's power up circuitry depends on the unit being fully powered down when voltage is applied - pulling the plug and immediately plugging the unit back in may cause the terminal to come up in some random state.

This completes the checkout phase. Although this doesn't guarantee that everything is working correctly. it does check most of the circuitry on the main unit which is helpful should you have problems with any of the option boards. You should now build, install and test your optional boards (such as the CT-S) following the instructions supplied with the option.

There are several points which should be noted when using the CT-64 terminal system:

1) When the UP jumper is in the S (scroll) position, toggling the SCRL pad will not change the unit back and forth between the page and scrolling modes.

2) When in the scrolling mode, a VERT. TAB (CTRL. K) will cause the terminal to change its "axis of scrolling" from the bottom line to whatever line the cursor is on.

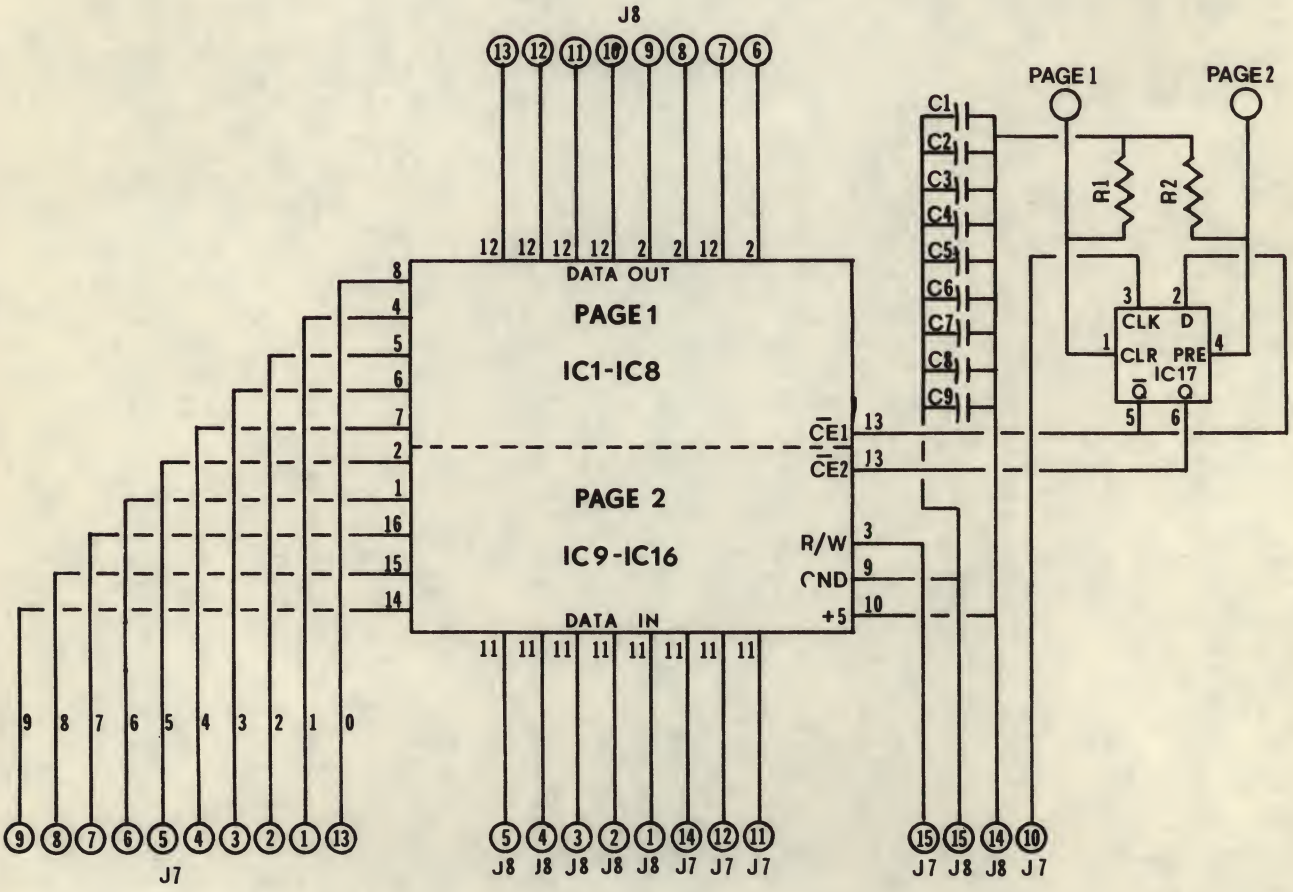
3) The cursor functions HOME UP and ERASE TO END OF FRAME are not defined for the scrolling mode and should only be used in the page mode.

4) When operating the CT-64 at high baud rates (600 or 1200), several nulls should be sent after C/R, L/F string to give the terminal time to bring up a clean line when in the scrolling mode.

Parts List - CT-64 Memory Board

IC1-8	2102-1 1024 x 500nS Static RAM (MOS)
IC17	7474 flip flop
C1-C8	0.1 mfd disc capacitor
C9	33 mfd electrolytic capacitor
R1-R2	1K ohm ¼ watt resistor

CT-64 MEMORY SCHEMATIC



Parts List - CT-64 Terminal Main Board

Resistors

___	R1	10K ohm 1/4 watt resistor
___	R2	220K " " " "
___	R3	2.2M " " " "
___	R4	1K " " " "
___	R5	100 " " " "
___	R6	1K " " " "
___	R7	10K " " " "
___	R8	2.2M " " " "
___	R9	33K " " " "
___	R10	1K " " " "
___	R11	50K ohm trimmer resistor
___	R12	10K ohm 1/4 watt resistor
___	R13	1K " " " "
___	R14	10K " " " "
___	R15	33K " " " "
___	R16	10K " " " "
___	R17	4.7K " " " "
___	R18	4.7K " " " "
___	R19	4.7K " " " "
___	R20	1K " " " "
___	R21	1K " " " "
___	R22	1K " " " "
___	R23	1K " " " "
___	R24	1K " " " "
___	R25	1K " " " "
___	R26	10K " " " "
___	R27	4.7K " " " "
___	R28	47 " " " "
___	R29	100 " " " "
___	R30	5K ohm trimmer resistor
___	R31	4.7K ohm 1/4 watt resistor
___	R32	1K " " " "
___	R33	5.6K " " " "
___	R34	1K " " " "
___	R35	1K " " " "
___	R36	1K " " " "
___	R37	1K " " " "
___	R38	1K " " " "
___	R39	1K " " " "
___	R40	1K " " " "
___	R41	1K " " " "
___	R42	1K " " " "
___	R43	1K " " " "
___	R44	1K " " " "
___	R45	1K " " " "
___	R46	1K " " " "
___	R47	1K " " " "
___	R48	1K " " " "
___	R49	1K " " " "
___	R50	1K " " " "
___	R51	1K " " " "
___	R52	1K " " " "

R53	1K	ohm 1/4 watt resistor
R54	1K	" " " "
R55	1K	" " " "
R56	10K	" " " "
R57	10K	" " " "
R58	10K	" " " "
R59	10K	" " " "
R60	10K	" " " "
R61	10K	" " " "
R62	10K	" " " "
R63	1K	" " " "
R64	20K	ohm trimmer resistor
R65	10K	ohm 1/4 watt resistor
R66	10K	" " " "
R67	10K	" " " "
R68	10K	" " " "
R69	10K	" " " "
R70	10K	" " " "
R71	560	" " " "
R72	47K	" " " "
R73	220K	" " " "

Capacitors

C1	0.22 mfd mylar capacitor
C2	470 pf disc capacitor
C3	0.01 mfd mylar capacitor
C4	0.01 " " "
C5	0.1 mfd disc capacitor
C6	0 1 " " "
C7	470 pf disc capacitor
C8	0.1 mfd mylar capacitor
C9	470 pf disc capacitor
C10	0.1 mfd mylar capacitor
C11	0.1 " " "
C12	0.1 " " "
C13	0.1 " " "
C14	1000 pf polystyrnen capacitor
* C15	100 mfd electrolytic capacitor
C16	33 " " "
C17	0.1 mfd disc capacitor
C18	0.1 " " "
C19	0.1 " " "
C20	4.7 pfd disc capacitor for 64 char./line, 100 pf for 32 char.
C21	3300 pf polystyrene capacitor
C22	0.1 mfd disc capacitor
C23	0.01 mfd mylar capacitor
* C24	100 mfd electrolytic capacitor
C25	0.1 mfd disc capacitor
C26	0.1 " " "
C27	0.1 " " "
C28	0.1 " " "
C29	0.1 " " "
C30	0.1 " " "
C31	0.1 " " "
C32	0.1 " " "

___	* ✓ C33	100 mfd electrolytic capacitor
___	✓ C34	0.01 mfd mylar capacitor
___	C35	0.1 mfd disc capacitor
___	✓ C36	0.047 mfd mylar capacitor
___	C37	not used in this kit
___	* ✓ C38	1 mfd tantalum capacitor

Semiconductors

___	* ✓ Q1	2N5129 silicon transistor
___	* ✓ Q2	2N5129 " "
___	* ✓ Q3	2N5139 " "
___	* ✓ Q4	TIS 58 field effect transistor
___	* ✓ Q5	TIS 58 " " "
___	* ✓ Q6	2N5210 silicon transistor
___	* ✓ D1	1N4148 silicon diode
___	* ✓ D2	1N4148 " "
___	* ✓ D3	1N4003 " "
___	* ✓ D4	1N4003 " "
___	* ✓ D5	1N4003 " "
___	* ✓ D6	1N4003 " "
___	* ✓ D7	1N4148 " "

Integrated Circuits

___	* ✓ IC1	555 or 1455 timer	
___	* ✓ IC2	7474 dual "D" flip-flop	
___	* ✓ IC3	7405 o.c. hex inverter	
___	* ✓ IC4	7474 dual "D" flip-flop	
___	* ✓ IC5	7408 quad AND gate	
___	* ✓ IC6	7493 4 bit binary counter	74193 X
___	* ✓ IC7	7493 " " " "	74193 X
___	* ✓ IC8	555 or 1455 timer	
___	* ✓ IC9	7474 dual "D" flip-flop	
___	* ✓ IC10	7432 quad OR gate	
___	* ✓ IC11	7451 dual AND-OR-INVERT gate	
___	* ✓ IC12	7420 dual 4 input NAND gate	
___	* ✓ IC13	7493 4 bit binary counter	74193 X
___	* ✓ IC14	74177 presettable binary counter	
___	* ✓ IC15	7474 dual "D" flip-flop	
___	* ✓ IC16	7400 quad NAND gate	
___	* ✓ IC17	7409 quad o.c. NAND gate	
___	* ✓ IC18	74123 dual one-shot	
___	* ✓ IC19	74132 quad Schmitt NAND gate	
___	* ✓ IC20	7405 o.c. hex inverter	
___	* ✓ IC21	74177 presettable binary counter	
___	* ✓ IC22	6575L character generator (MOS)	
___	* ✓ IC23	74166 8 bit shift register	
___	* ✓ IC24	74161 synchronout 4 bit counter	
___	* ✓ IC25	7410 triple 3 input NAND gate	
___	* ✓ IC26	7409 quad o.c. NAND gate	

___ * IC27 7474 dual "D" flip-flop
___ * IC28 74193 4 bit UP/DOWN counter
___ * IC29 7408 quad AND gate
___ * IC30 74175 quad "D" flip-flop
___ * IC31 7486 quad EXCLUSIVE OR gate
___ * IC32 7432 quad OR gate
___ * IC33 7408 quad AND gate
___ * IC34 74193 4 bit UP/DOWN counter
___ * IC35 74193 " " " "
___ * IC36 74174 hex "D" flip-flop
___ * IC37 7474 dual "D" flip-flop
___ * IC38 7430 8 input NAND gate
___ * IC39 7400 quad NAND gate
___ * IC40 74LS266 quad EXCLUSIVE NOR gate
___ * IC41 7485 4 bit comparator
___ * IC42 7485 " " "
___ * IC43 74154 4 to 16 decoder
___ * IC44 74154 " " " "
___ * IC45 7432 quad OR gate
___ * IC46 7474 dual "D" flip-flop
___ * IC47 555 or 1455 timer

* denotes that this part is polarized and must be inserted as shown on the component layout drawing.

Use of the CT-64 's Control Character Decoding

The CT-64 contains the necessary circuitry to decode all 32 ASCII control characters. Some of the functions are already dedicated in the p.c. layout of the terminal, while others are available for custom use. Below is a table listing all possible combinations. Those denoted UD are spares which can be "user defined" for special applications.

HEX ASCII BIT PATTERN	ASCII CTRL. LETTER		DECODER/PIN		FUNCTION
00	NUL	@	IC44	1	UD
01	SOH	A		2	UD
02	STX	B	HOME	3	UD
BREAK 03	ETX	C	CLEAR EOL	4	UD
04	EOT	D	CLEAR EOS	5	UD
05	ENQ	E	→	6	UD
06	ACK	F	↑	7	UD
07	BEL	G		8	BELL
08	BS	H		9	BACK SPACE
09	HT	I		10	HORIZ. TAB
0A	LF	J		11	LINE FEED
0B	VT	K		13	VERT. TAB
CUR ON/OFF 0C	FF	L		14	UD
0D	CR	M		15	CAR. RETN.
0E	SO	N		16	UD
0F	SI	O		17	UD
HOME-UP 10	DLE	P	IC43	1	UD
11	DC1	Q		2	PUNCH ON (J1-8)
12	DC2	R		3	READ ON (J1-7)
13	DC3	S		4	PUNCH OFF (J1-6)
14	DC4	T		5	READ OFF (J1-5)
ERASE EOL - 15	NAK	U	REV	6	UD
ERASE EOF - 16	SYN	V	SCR./PAGE	7	UD
→ CUR. RIGHT 17	ETB	W	CUR ON/OF	8	UD
DEL. LINE 18	CAN	X	CUR SOL/BLK	9	UD
REV. 19	EM	Y		10	UD
SOL.BLK 1A	SUB	Z		11	UD
1B	ESC	(		13	UD
1C	FS	\		14	UD
1D	GS	)		15	UD
1E	RS	↑		16	UD
1F	US	←		17	UD

All decoded outputs are active low (the appropriate pin goes low for about 1 usec for the decoded character). For convenience the UD pins are brought out to labeled pads (F E D .....) on the main board.

The small pad on the rear of the main board marked "BELL" can be used to trigger a small signalling device, such as a Sonalert^{R} or equiv., whenever a CTRL. G is encountered or when 16 lines of data have been displayed. The BELL pulse is positive going to +5 volts and can source 200 mA.

To use the decoded outputs to control SCROLL/PAGE, CURSOR ON/OFF, CURSOR SOLID/BLINK, SCREEN REVERSE and PAGE SELECT simply jumper from the appropriate function pad to the desired decoder output pin. For example connecting a wire from decoder pin N (IC44 pin 16) to the SCRL pad will change the terminal back and forth from the scrolling and page mode each time a CTRL. N is encountered. The decoded outputs can also be connected to the home up, erase end of frame, etc. pins of J2.

HOW IT WORKS

The CT-64 character display has been arranged to provide 16 lines of either 32 or 64 characters per line. Each character displayed is actually an array of 63 dots on the screen. The proper pattern of dots for the character being displayed is generated by the 6575L character generator, which decodes the binary ASCII data presented to it. Since televisions sweep the trace horizontally, one video line at a time, the dots are selected one character row at a time. Horizontal spacing between characters is provided by displaying a blank dot column between each character. Vertical spacing between lines is provided by sweeping four blank video lines between each of the nine "character dot video" lines. Three of the four blank lines are used to present the dots associated with lower case letters which descend below the main row base line (i.e., g,j,p,etc.). The shift for these letters is performed by the 6575L character generator. This means that our vertical data is 13 character video lines x 16 character rows = 208 "character dot video" lines. The television or video monitor also requires a vertical and horizontal sync pulse in addition to the actual video data, so the CT-64 generates these signals as well.

The time base oscillator, as indicated in the schematic, is responsible for initiating the horizontal sync pulse and for starting the chain of events that will generate one line of video data to be displayed. The circuit itself is a phase locked loop employed as a frequency multiplier. IC1 is used as an astable voltage controlled oscillator, with bipolar transistor Q3 and field effect transistor (FET) Q4 along with capacitor C36 forming a sample and hold circuit which feeds IC1's voltage control input through FET Q5. The sample and hold in this case is being used as a phase comparator, providing an output voltage proportional to the phase difference of the 60 Hz power line and the multiplied output frequency of IC1. The actual amount of frequency multiplication is equal to the amount of frequency division between the output of oscillator IC1 and the input reference frequency. As we will see later, the value of the frequency divider is 264 and, since our reference is 60 Hz, the fo=60 Hz x 264=15840 Hz, which is very close to the horizontal oscillator frequency of a standard video monitor. This method of generating the horizontal sync signal provides for an extremely stable character display. The output of IC1 is fed via inverter IC20 B to IC19 B and C where, among other things, a 4 microsecond horizontal sync pulse is generated. From here the pulse is routed to IC17 A where it is ORed with the vertical sync pulse which will be described later.

The falling edge of this sync pulse at the output of IC19 C triggers IC18 A, a one shot, which puts out a positive pulse on pin 4 adjustable by potentiometer R64 from 4 to 20 microseconds. The delay pulse creates a lag between the television's start of the video sweep and the CT-2048's generation of data, thus giving an adjustable left margin. Pin 4 of IC18 A also inhibits dot oscillator IC18 B through AND-OR-INVERT gate IC11 A. This pulse also resets IC21 and IC14, the 16 bit counters which keep track of the selected horizontal character. Since we are

just starting a new line we must first clear these counters to prepare them for incoming data. The high to low transition of pin 4 clocks IC6, the rowcounter, and, if there is a ripple carry, IC7 and IC13, the timing line and scrolling line counters, are incremented as well.

The row counter, IC6, is a BCD counter which keeps track of each of the 13 lines forming a character row. Remember we said earlier that each character would be formed by nine vertical dot lines and four blank lines, three of which are used for descending lower case characters. IC6 has a distinct BCD output for each of these 13 lines and tells the rest of the circuitry which of the 13 lines it is generating. Since we also have 16 sets of 13 lines, one set for each character row, we must have a 16 bit counter, IC7, to tell the rest of the circuitry which of the 16 character lines it is displaying. Together IC6 and IC7 provide a unique BCD code for each of the 13 x 16 = 208 dot video scan lines. IC13 also provides a unique BCD code for each of the 16 character rows, however, its output is used to address the CT-64 memory to allow scrolling which will be described in detail later.

Now for those of you familiar with television circuits, you probably know that we need more like 262 lines and not 208 lines for a complete frame and, since our scan counters IC6 and IC7 are only good to 208, we let them continue counting past 208 since the bit pattern is the same as if we had reset them. Flipflop IC4 B, which has been in the Q output = 1 state during the first 208 lines, is now toggled to the Q = 0 state through AND gate IC5 C and NAND gate IC19 A. When IC4 B toggles, a sample command is instigated for the sample and hold portion of the time base oscillator which was described earlier. It also disables the character shift register, IC23 by inhibiting the dot clock output from pin 6 IC11A. This mode continues line by line until the counter reaches a count of 13. Lines 13 through 26 are then used to generate the vertical sync pulse required by the television. NAND gate IC12 A, along with inverter, IC20 C, perform the actual line number decoding. Note the output of the time base oscillator in NANDed as well in IC12 A along with the line counter data. This chops the vertical sync signal as required by the television. The output of IC12 A is fed to IC17 A where it is combined with the horizontal sync signal to form the composite video signal at the output of AND gate IC17 A. The vertical sync pulse is stopped at line 26 and the line and row counters continue to count to 54, which is decoded by IC12 B. Note that the Q output of IC4 B is NANDed as well by the decoder IC12 B since the 53 count is not significant during the "display dot video" mode. The output of IC12 B in turn generates a positive clock pulse to IC4 B through AND gate IC5 C making the Q output of IC4 B high again as it was when we started. The same signal from IC12 B resets the row counter IC6 and line counter IC7 and, if not in the "scrolling mode", the scrolling line counter, IC13, to a count of 0, thus completing a 262 line/frame cycle of 208 lines of video, 13 lines of blanking, 13 lines of vertical sync, and 28 more of blanking.

Now lets get back to the horizontal portion of the circuit again. We left off earlier by saying that one shot oscillator, IC18 A, provided an adjustable delay between the horizontal sync pulse and the generation of data to provide a left margin. We also said that an astable oscillator IC18 B, which is inhibited during this delay phase via IC11 A, is the dot generator which actually clocks off the dots for each line of video which form the character. So from here we may continue by saying that potentiometer R6 sets the cycle time for this oscillator from 75 to 300 nS which in turn sets horizontal width of the characters displayed. The dot clock output, however, is not the output of IC18 B, but rather the output of AND-OR-INVERT gate IC11 A. Its output is normally high, but goes low for about 30nS each time IC18 B resets. This 30 nS pulse time is set by the propagation time of IC18 B and IC11 A and is very hard, if not impossible, to see with most oscilloscopes. This "dot clock" is used to toggle the "dot bit" shift register, IC23 and the "dot counter" IC24.

The horizontal dot data for each character is composed of seven dots and one blank for spacing on each video scan line for each of the 13 vertical character data lines. The video dot data for the horizontal portion of each character are parallel loaded from the 6575L character generator into IC23, the 8 bit shift register. The data is then serially shifted out of the shift register by the "dot clock" which also clocks IC24, the "dot counter". The serial data from IC23 is sent to IC17 D where it is mixed with the horizontal and vertical sync pulses to form the composite video signal. The emitter follower arrangement of Q1 buffers the composite video signal to a 1 volt peak to peak signal which is used by the video monitor.

The "dot counter" IC24 counts out each of the data bits shifted from IC23 as was mentioned earlier, IC24 C monitors the output of the "dot counter" and its output, pin 6, goes low when the counter reaches a count of 8. This low pulse sets up the dot register IC23 to parallel load new data from the character generator when the next "dot clock" signal arrives a the shift register. The low pulse from IC24 C also increments IC24 and, if there is a ripple carry, IC14, thus keeping track of which character position we are working with. Figure 1 shows the sequence of events which occurs as the data is shifted out. Note that it is this sequence which determines the frequency of the video signal. For example, when in the 64 character mode serial bit data must be provided at a rate which will provide 8 dots/character x 64 characters/row 512 serial dots/video row within the time it takes the television to scan one video line. Allowing 4 ms for horizontal sync, 5ms of blanking at the beginning of the line and 5 ms of blanking at the end of the video line, we are left with 51 ms of the 66ms required to scan one video line, in which to provide the character data to the monitor. Now 51 ms/512 serial dots $\approx$ 100 ns/serial dot which is equivalent to a 10 MHz composite video signal. For this reason we recommend that the CT-64 be used with a video monitor with at least 10 MHz frequency response when operating in the 64 character/line mode. When in the 32 character/line mode a similar calculation yields a 5 MHz signal which is the upper limit of most high quality television sets.

memory at the time of the "keypressed strobe" is completely arbitrary and is not, most likely, the place where we want to store the character. Keep in mind that the CT-64 also has the capability of decoding all 32 of the standard ASCII control characters which we probably don't want to write into memory.

The latched input character mentioned earlier is fed to the function decode circuitry where it is determined whether or not a control function is being inputted. If it is, such as any input with bits 6 and 7 equal to zero or a rubout with all bits set to 1, the output of IC39 B will go high, forcing the output of IC11 B low resetting IC9 B and preparing IC27 A to dump the input control character on the next load pulse for the "dot register" IC23 from IC24 C. Note the next time the clock input on IC27 A goes high, it clears all of the data input latches IC36, IC37 A and IC37 B. If the inputted character is a control character decoders IC43 and IC44 are enabled through IC45 A. These decoders each have 16 outputs which allow decoding of each of the 32 different control functions. Note that although 16 of the control functions are in use 16 are available for auxiliary control purposes. These 16 outputs are provided with pads which enables patching them to the auxiliary jack J1, pins 1,2,3,4.

Getting back to our latched character, if the character is a printable one IC39 B will stay low thus eliminating IC9 B's clear command allowing its Q output to remain a 1. On the next "dot register" load pulse IC30 D is clocked high. The high output of IC9 B and IC30 C are now ANDed in IC30 A whose output allows IC30 C to be clocked high on the next "load pulse". IC30 C's Q output is fed to IC19 D where it waits for a "compare" command from AND gate IC33 D. The input from IC30 F is ANDed with the "compare' command in IC33 D to eliminate false counts when the end of the character line is reached. The compare circuit will be described in detail later but basically it determines when the memory is indexed to the position in which we want to store the character being processed. When the compare is confirmed, IC33 D goes high forcing IC19 D low. This makes IC39 C go high generating a write pulse for the memory, thus loading the character in the proper location. At the onset of the next load pulse IC33 B goes high forcing IC11 B low which resets IC9 B and dumps the input latches, leaving the ASCII code for a blank stored. IC30 C and 30 D both reset on the the following "dot register" load pulse.

The cursor and compare circuits are very interrelated since the circuitry must know where the cursor is positioned on the screen. This is required so when the memory is indexed to match with the cursor location the cursor will blink at the proper position. Since the character we will load through the keyboard will be entered in the cursor's position the cursor counter must provide the address where the character will be loaded into memory. This reference address is stored in a 10 bit counter made up of IC35, IC28 and IC34. IC35 holds the data for the first 16 horizontal character locations and IC28 holds the data for locations 17-64 (32 in the 32 character/line mode). The number

As mentioned earlier, IC21 and IC14 count each of the characters displayed in each row. When these counters reach a count of 65 (or 33 in the 32 character/line mode) the dot clock is inhibited through IC11 A until a new line is started. The horizontal sync pulse clears these counters as well as the "dot register", IC23, and "dot counter", IC24, to 0, thus preparing them for the next line of data.

The CT-64 can be operated in either a page or scrolling mode. Flipflop IC2 B is the mode control storage latch which is toggled by a low on the SCRL pad. When in the normal mode, IC13, the "scrolling row counter", is clocked and cleared by the same signals as IC7, the "timing row counter". IC13 is only clocked while in the display character mode, as the clock is inhibited when IC4 B's Q output = 0. Thus IC13 keeps track of each of the 16 character rows while IC7 continues counting to keep track of the entire video display.

When in the scrolling mode the clear pulse to IC13 is inhibited through IC5A and its BCD output is allowed to continue independently of IC7, the "timing row counter". Scrolling is accomplished by providing IC13 with an additional clocking pulse through IC10 D and IC3 D. The additional clock pulse results in rolling the entire screen up one line. When a carriage return is received IC4 A is set and after the next clock pulse is received IC13 is again clocked through IC10 D via IC10 D and IC3 D. This extra clock pulse resets IC4 A and generates an erase to end of line (EOL) pulse through IC3 C so the bottom line will come up clean. Flipflop IC2 A is provided to prevent initiation of the scrolling mode until the end of the 16th row of data, thus allowing the entire screen to be filled before scrolling is begun.

The board has been set up to provide scrolling upon receiving a carriage return rather than a line feed to facilitate using it in an off line mode. This provision is entirely transparent while on line with a computer as the line feed signal is inhibited through IC45C. Should the user require separate CR and LF control while in the scrolling mode the modification can be made at point H on the board.

Now that we know how to get the data from the 6575L character generator data inputs to the screen, lets see how the incoming data is put into and accessed from memory. We must first have some means of inputting data to the CT-64 which, in most cases, will be a standard seven bit ASCII encoded keyboard. The input device must also provide a "keypressed strobe" pulse to tell the CT-64 when a key has been pressed. Although the seven data bits are set up for positive logic, the "keypressed strobe" line may be either positive or negative going, since exclusive or gate IC31 B has been provided as an optional inverter. When the "keypressed strobe" pulse reaches the "clock" input of IC9 B it toggles IC9 B forcing IC36 and IC37 B to latch onto the new ASCII data provided at the data inputs. IC37A is also clocked latching IC30 onto the 8th data bit which is used to invert the field of that particular character. Each of these 8 latched data bits is fed to the input terminals of the RAM memory, but not loaded. You must remember that the memory is constantly being readdressed and read. The address of

of the 16 character rows is stored in IC34 while IC17 on the memory board holds the bit addressing one of the two pages of memory.

IC41, IC42, IC40 C and IC40 D provide a 10 bit comparator which tell us when the data on two sets of inputs are equal. The two sets of input data to the comparators are the cursor and memory address. When the cursor address and location of memory presently being indexed are equal the cascaded comparators generate an equal pulse. This equal pulse is provided at pin 6, IC41, as an active high "compare".

The cursor itself is generated by inverting the field of the character position it is located at. This occurs when IC17 C sees both an active compare and a cursor on signal from flipflop IC46 A. The several times per second blinking is generated by timer IC8 operating as an astable oscillator. Flipflop IC46 B inhibits this oscillator when a solid cursor is required. The actual field inversion occurs by inverting the pin 9 input of EXCLUSIVE OR gate IC31 C. As mentioned earlier, the 8th data bit stored in memory also provides field inversion on specific characters therefore the cursor and 8th bit are EXCLUSIVE ORed in IC31 A. The output of IC31 A is sent to IC30 B where is it latched by the "dot register" load pulse and held throughout the time that characters serial shift. IC39 C and 29 D prevent the inversion during the blanked portion of the display.

The cursor is positioned by incrementing and decrementing the up/down cursor counters IC35, IC28 snd IC34 which have full wrap around in each location. Although all of the cursor control circuitry has been provided with control characters on the main board provisions for manual cursor control are provided at J2 on the board. These inputs will require external debounce as none is provided on the main board. Manual cursor control is initiated by an active low.

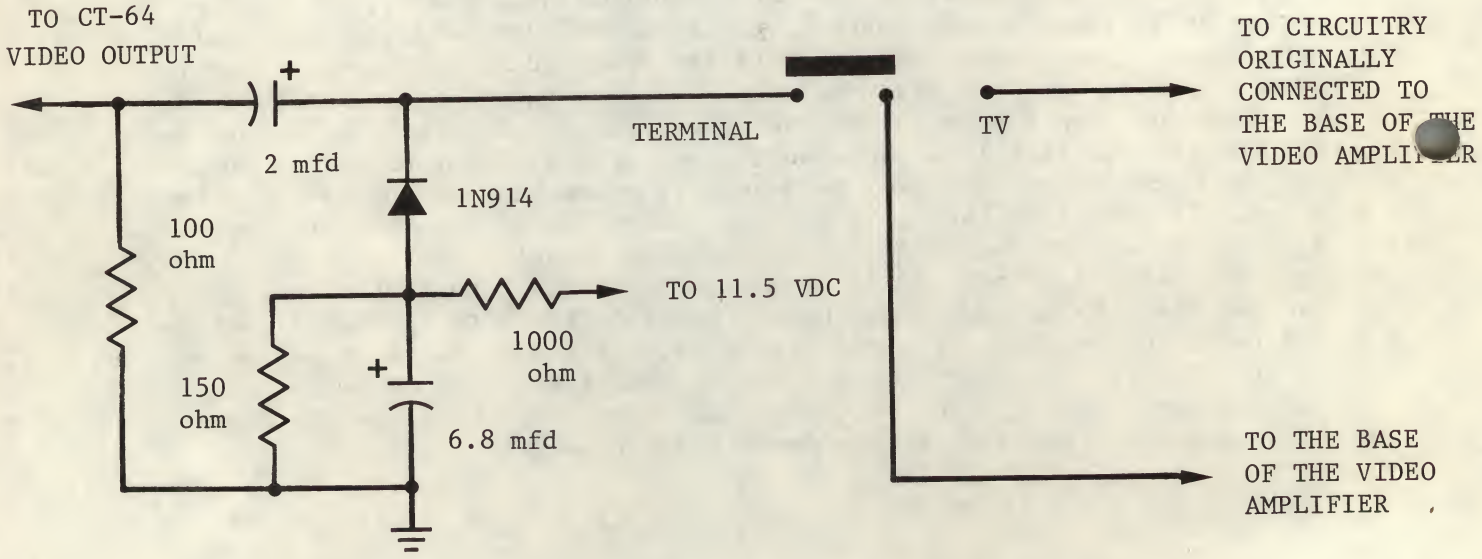
Control character home up, erase to end of line and erase to end of frame have not been provided as ASCII control functions but can be implemented by jumpering the output of the control decoders to the specific pins of J2. These functions were not incorporated in the basic design to avoid conflict with the many different software packages available. Leaving them for jumper hookup increases the terminals flexibility. Erase to the end of line is initiated by setting the preset input of IC15 B low, and the erase to end of frame is initiated by setting the preset of IC15 A low. If either of these two latches is set, it allows IC9 A to toggle at the onset of the next compare when the row counter reaches line 13. Thes generates a "memory load" command which loads a space from the input latches into memory. IC15 B will reset on the 65th character position (33 in 32 characters/line mode) from IC14 thus completing an erase to end of line (EOL). IC 15 A will be reset on the first blanking pulse from IC4 B after IC7 A has been set thus completing an erase to end of frame (EOF). The resetting of either cause IC9 A to reset.

Page 1-2 changes are initiated by toggling IC17 A on the memory board by sending a low pulse to the PAGE terminal. These may also be manually flipped by wiring a switch to the terminals marked page 1 and page 2 in the upper right of the memory board. A single pole double throw center off switch with the common wired to ground will provide manual page select with control character select when in the center off position.

There are several jumpers on the main board in addition to locations D, E and F which are used to select 32 or 64 characters/line and are described in the assembly instructions. Location G is provided if you plan to use your terminal with 50 Hz, 625 line European service or you plan to use a high resolution 725 line TV monitor. Cutting the trace by the indicated arrow and jumpering the G terminals will increase the normal 13 video line character row to 16 lines thus giving 256 video display lines, 16 lines of blanking, 16 lines of vertical sync and 34 more lines of blanking thus giving a display compatable with a 625 line television,

Jumper Terminal location H provides the user with the ability to not inhibit the line feed signal while in the scrolling mode.

The 65 75 L character generator will provide an output for all of the 32 ASCII control characters. The board has been set up to dump these characters rather than print them. If the user requires that these characters be printed location B has been provided to perform this function. Cutting the trace as indicated by the arrows at location B and installing a jumper from terminal B to the ground terminal directly above it will inhibit the control character dump signal from IC39 D and allow the control characters to be stored.



Video Input Modification for a Small Motorola Television

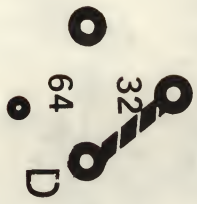
Television Modification

The CT-64 has been designed to operate with a standard video monitor. Because of the bandwidth involved modified television sets are not guaranteed to give a satisfactory display. If the CT-2048 is programmed for 32 characters/line a TV should work, but at 64 char./line the characters may become fuzzier and the display less stable. Included is a brief summary of the modifications that were made to a small television to convert it to a limited bandwidth monitor. The terminal should be connected directly into the video of the television and not be connected through the antenna terminals via some type RF modulator. If you are going to buy a television to modify to use with the CT-2048 we highly recommend that you spend a few dollars more and purchase a 10 MHz video monitor.

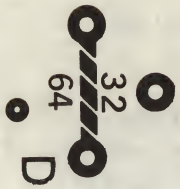
Although the actual modifications necessary will vary from set to set, the modifications shown will probably be satisfactory for most small screened transistor portables. The terminal's output must be connected to the input of the television's video amplifier, which is located between the last video IF stage and the video output circuit. When you break the circuit right at the input to the video amplifier, you will probably have to provide a DC bias circuit for the stage since in most cases it is supplied by the now disconnected video IF amplifier. The circuit shown in figure 2 is for the Motorola 9TS-469 Q set used with the prototype. A switch and BNC connector were provided to allow either T.V. typewriter or normal television viewing, however a RCA type connector can be used. A 10 pfd capacitor was connected from the screen grid (pin 6) to cathode (pin 2) of the CRT to flatten out a peak the television's response. This is not necessary on all sets but if so corrects a peak which causes the character's left side to be brighter than the right side.

A DC restore circuit was also added to prevent the screen intensity from changing as a function of the density of dots displayed. It consists of two series 1N914 diodes in parallel with the resistor coming off the wiper of the brightness control going to the cathode resistor of the CRT. The cathode end of the diodes goes toward the wiper of the control. A 2 mfd @ 250 VDC non-polarized capacitor is also connected from the wiper of the brightness control to the grid (pin 6) CRT where the 10 pfd capacitor was just connected.

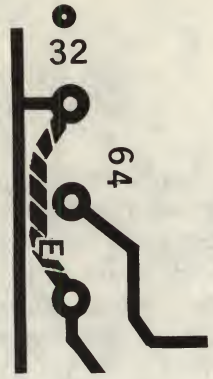
CT-64 JUMPERS



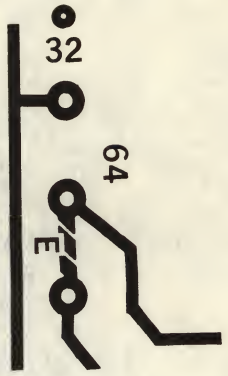
32 CHARACTER



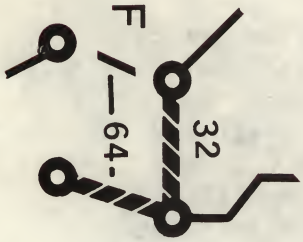
64 CHARACTER



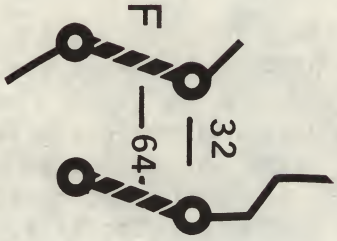
32 CHARACTER



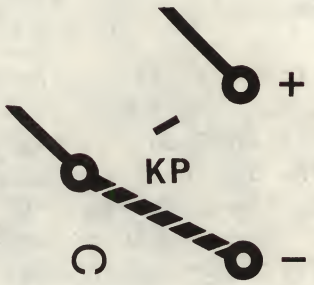
64 CHARACTER



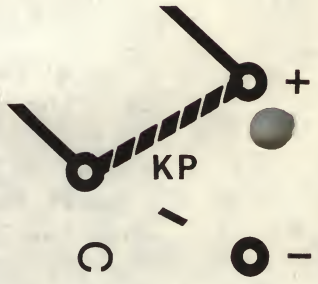
32 CHARACTER



64 CHARACTER

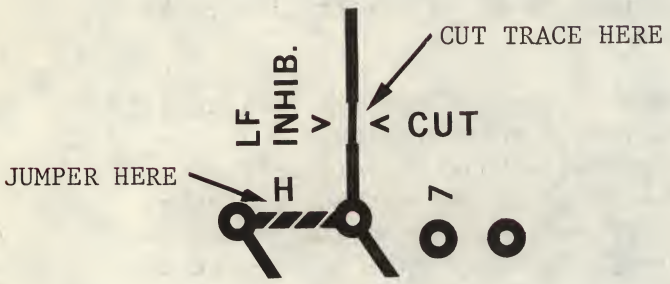


NEGATIVE

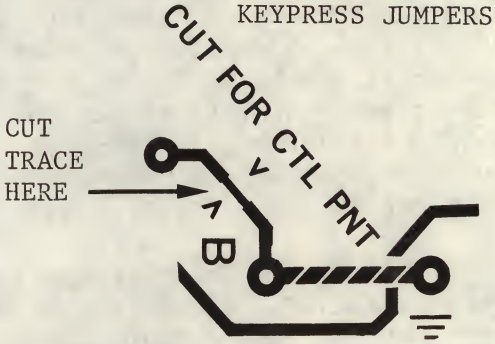


POSITIVE

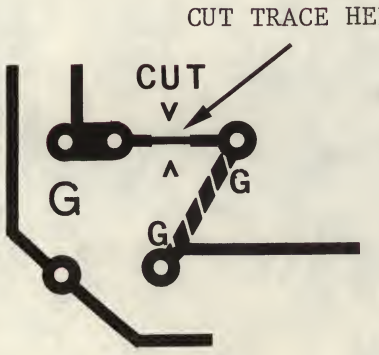
KEYPRESS JUMPERS



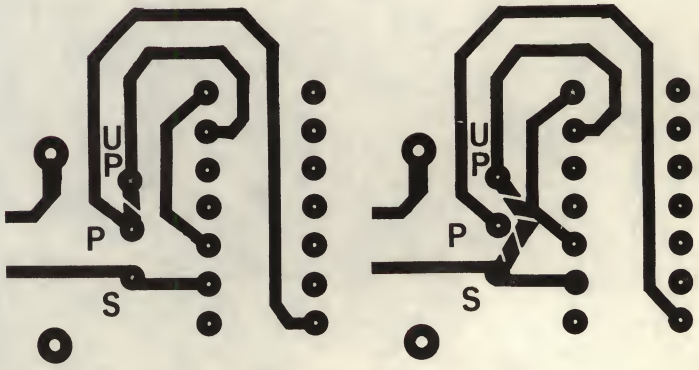
LINE FEED INHIBIT MODIFICATION



CONTROL CHARACTER PRINT MODIFICATION

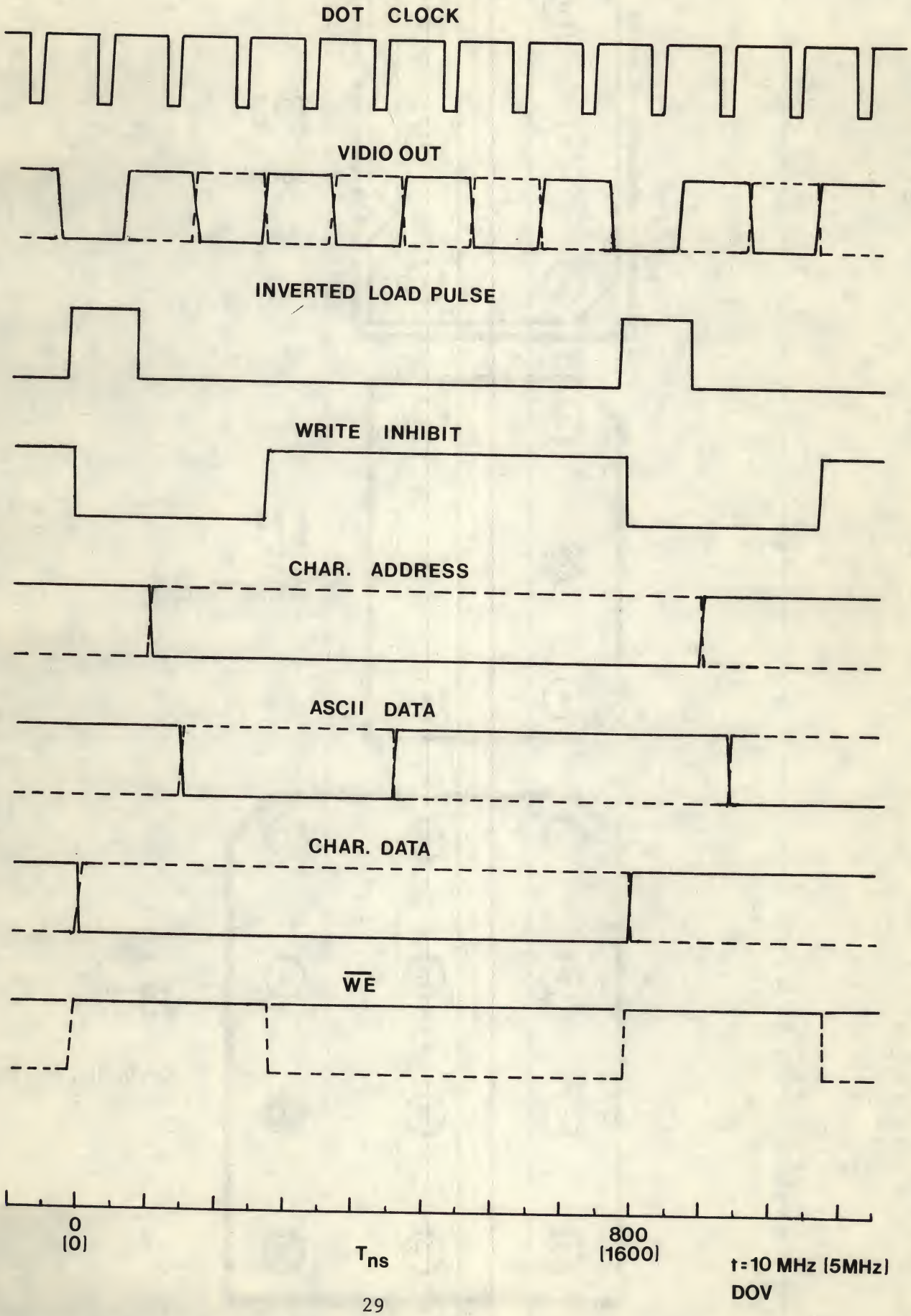


625 LINE MODIFICATION
FOR EUROPEAN OPERATION



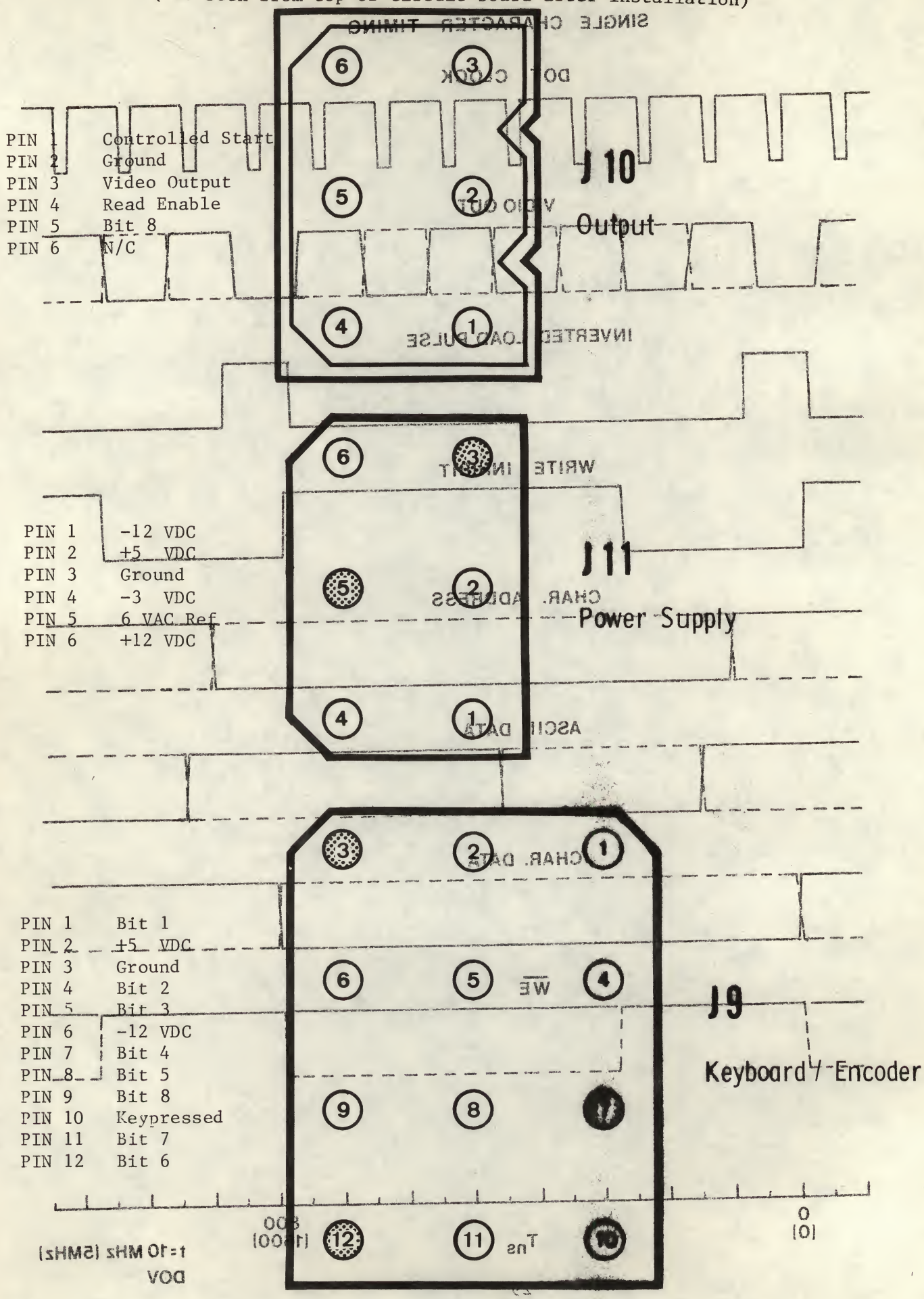
PAGE/SCROLLING POWER UP

SINGLE CHARACTER TIMING



Connector Drawing

(as seen from top of circuit board after installation)



In Case of Problems

Carefully compare the parts list against the finished unit. Rather than suspect a defective pack, be sure that there is not an interchanged or reversed transistor, capacitor or IC. The majority of the difficulties had with the terminal are attributable to incorrect assembly. Read the "HOW IT WORKS" section of the instruction set so as to trouble shoot section by section with an oscilloscope.

REMEMBER- A large number of kits sent in for repair fail to operate because of an obscure solder bridge or a misplaced part of jumper. Triple checking your kit completely, part by part, could save you a repair charge.

MONITOR- The Motorola® monitor is factory assembled and tested. If the unit will not operate due to a manufacturing defect, return the kit to us. Do not attempt to service the monitor. File a claim with the postal authorities if there is any postal damage.

Repair Service

If you have a problem that you cannot solve, the kit may be returned for factory service. Please return the entire* unit (chassis, case, PC boards, etc.) and remove all modifications and additions. Do not return the monitor unless it is defective.

* Remove the power transformer. This reduces postal costs and damage. Selected individual boards may be returned but in most cases it is best to send the entire unit.

Repairs are performed for a flat labor charge per defective board plus parts and postage.

CIRCUIT	LABOR CHARGE*
Main board	$25.00
Memory board	8.00
Serial Interface	12.00
Keyboard	10.00
Power Supply	8.00
Monitor	25.00

* A $10.00 checkout charge will be added for a complete unit.

If we find that the board or complete unit is functional as received and does not require service, the check-out charge is $5.00 for an individual board and $10.00 for a complete unit.

A confirmation sheet will be sent upon receipt of the kit. Please do not ask for an estimate or a detailed report on exactly what was done in repairing your unit as we cannot provide this service.

It is not necessary to enclose any funds with the kit, you will be billed for authorized repairs.

(Shipping instructions on back)

SHIPPING INSTRUCTIONS

- Pack in a large carton with at least 3 inches of padding on all sides. Do not attempt to return the kit in the original box. We will not service a kit if there is any postal damage until the claim is settled.

- Include all relevant correspondence and a brief description of the difficulty.

- Ship prepaid by UPS or insured Parcel Post. We cannot pick up repairs sent by bus.

- Ship to: Southwest Technical Products Corp.
  Repair Department - Digital Group
  219 W. Rhapsody
  San Antonio, Texas 78216